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SUMMARY

Problem

The current ground casualty projection tool, FORECAS, provides casualty forecasts for large geographical regions and bases these projections on empirical data from four previous ground operations. The Gulf War pointed out that not all adversaries will mount the same resistance as was evidenced in the Marine deployments to Okinawa, Korea, and Vietnam.

Objective

The present investigation seeks to refine FORECAS projections by incorporating "adversary-specific" variables that may impact U.S. casualty incidence.

Approach

Two sets of variables that impact casualty sustainment were investigated for the U.S. and potential adversaries. Societal factors potentially influencing battlefield motivation and weapons inventories were examined to determine their potential casualty sustainment weights and their respective values among U.S. and potential opposition nations.

Results

Societal factors judged to be determinants of combat motivation included battlefield experience, societal homogeneity, defense spending priority, technological sophistication, and primary group factors such as leadership, camraderie, and training. Weapons categories potentially impacting U.S. casualty sustainment included artillery, armor, infantry, and airborne attack systems possessed by the opposing forces.

Conclusions

Societal factors and weapons armaments possessed by potential adversaries need to be incorporated into casualty projections for future ground scenarios. The present FORECAS methodology allows the robustness of the historical data to be incorporated into casualty projections, while at the same time including adjustments necessary to reflect the capabilities of specific adversaries.

INCORPORATING ADVERSARY-SPECIFIC ADJUSTMENTS INTO THE FORECAS GROUND CASUALTY PROJECTION MODEL

The FORECAS ground casualty projection system is an interactive tool designed to provide medical requirements specialists with estimates of the numbers of casualties that may be incurred during various combat scenarios. Additionally, FORECAS displays graphs of the expected pulses and pauses in daily casualty incidence providing medical planners with the maximum likely daily patient load. The projections provided by the FORECAS system include wounded-in-action (WIA), killed-in-action (KIA), and disease and nonbattle injury (DNBI) incidence for U.S. Marine forces.

Casualty and DNBI projections are contingent upon user-supplied parameters such as battle intensity level (no combat, low, medium, heavy, intense), troop strength (population-at-risk), troop type (infantry, combat support, service support), and length of combat operation. The casualty estimates are based on empirical data[1,2] from four previous ground operations: U.S. Marines deployed to Okinawa, Korea, and Vietnam, and the United Kingdom Amphibious Force (UKAF) in the Falklands War. These historical data were analyzed to determine casualty and disease patterns for troops during various combat intensities; casualty and DNBI means were then incorporated into the FORECAS system, as were statistically significant trends.[3]

Currently, the FORECAS planning tool provides projections for large geographical regions -- East Asia, Southwest Asia, and Europe. As was observed in the Gulf War, however, not all present-day adversaries will mount the same resistance on the battlefield as evidenced in the deployments to Okinawa, Korea, and Vietnam. The present investigation, therefore, seeks to refine casualty rate projections by examining adversary-specific variables that may influence U.S. casualty incidence. Two sets of variables impacting casualty rates -- societal/cultural factors and weapons inventories -- will be examined for the U.S and various

potential adversaries. Societal factors and weapons parity scores will be computed for the U.S. and potential opposition forces so that this information may be incorporated into the FORECAS casualty projection system and more accurate forecasts obtained.

HUMAN FACTORS PARITY

Quantification of the societal/cultural factors influencing battlefield performance first requires ascertainment of the variables that may be determinants of combat behavior. The 'sociology of combat' has been the focus of much research and several schools of thought have been advanced to explain a nation's military effectiveness.[4,5] One philosophy maintains that battlefield motivation derives from a national character intrinsic to the general populace of a nation. This school of thought holds that an intangible martial spirit is imbued, through various mechanisms, in a nation's citizenry and the strength of this fighting spirit is manifested on the battlefield. A second, related viewpoint, holds that effective soldiers are ideologically inspired, fighting out of national patriotism, a belief in the justness of the cause, or for a way of life.

Two other contrasting explanations of combat motivation[6] derive from dynamics within the military organization itself rather than in society at large. One of these theories holds that battlefield performance is a function of military-wide dynamics -- factors such as organizational leadership, esprit de corps, and discipline. This viewpoint stresses the military organization as being the principal influence of combat behavior and that forces external to the organization have but minimal impact on performance. Another similar theory which attempts to explain combat motivation maintains that individual soldiers are driven by much smaller 'primary groups' to which they belong rather than by the organization as a whole. This philosophy holds that the dynamics within the combat unit -- be it a platoon, company, or battalion -- are the overriding determinants to battlefield performance. Under this paradigm, it is the cohesion, morale, training, and discipline within the combat unit which ultimately motivates the individual soldier.

It is doubtful that any one of these theories explains combat performance to the total exclusion of all the others. Rather, the individual soldier's actions on the battlefield are more likely an amalgam of all these influences. As such, it is difficult to quantify the factors that may give one military force an edge over its opposition. Nevertheless, examination of societal/cultural variables that reflect these motivational tenets may prove useful in computing the adjustments to the baseline rate projections needed to make the casualty forecasts 'adversary-specific'.

SOCIETAL FACTORS AFFECTING PERFORMANCE

Subject Matter Experts (SME) with backgrounds in casualty rate estimation were recruited to participate on a panel quantifying human factors adjustments to the baseline casualty estimates. The panelists were: a former Commander of the Army Research Institute for the Behavioral and Social Sciences; a Senior Scientist at the Center for Modeling, Simulation, and Gaming with extensive research experience projecting battlefield dynamics; a Senior Analyst from the Office of the Deputy Under Secretary of the Army (Operations Research); an accomplished wargamer and author of 20 books on the history of war; the developer of the casualty projection system (CASEST) approved for use by the Marine Corps; a Program Manager of Campaign Simulation projects from The Dupuy Institute; and a former Navy psychiatrist with research experience focusing on battle fatigue and combat casualties. Each panelist was provided with publications detailing the present FORECAS system and underlying data[1-3] as well as extensive readings on factors underlying combat performance.[4-9] Figure 1 is a display of the variables that SME members were asked to consider as potential determinants of combat behavior. These variables clustered within three large motivational constructs: cohesion, national morale, and armed forces-wide esprit de corps. Panelists were instructed not to feel constrained by the variables provided but that a necessary criteria for any additional variables was data availability, a not insubstantial concern when focusing on nations that represent potential adversaries, some of which are relatively closed societies.

After in-depth discussions on the various factors, the panel was able to reach consensus on nine variables that would impact battlefield performance, and potentially an opposition

force's ability to inflict casualties. These factors, seen in Figure 2 generally fell into the categories of 1) Technological Sophistication, 2) Group Cohesion, and 3) Armed Forces-wide Esprit de Corps.

The panel members reached consensus that the **technological sophistication** of individual members of an armed force would be a factor influencing battlefield performance. Further, they agreed that electrical consumption per capita would be a rough indicator of the technological sophistication of a nation's populace. Electrical consumption per capita, in the present study, was computed as *thousand metric tons of coal equivalent/population.* Interestingly, in an earlier study examining combat effectiveness,[7] factors related to societal industrialization, particularly electrical production, showed strong positive correlations with combat effectiveness.

In discussions of the second category, **group cohesion**, panel members agreed that this factor, previously reported to influence battlefield performance[8], should generally be reflected by the overall level of societal homogeneity. In turn, ethnic homogeneity and religious homogeniety were judged to be valid indices of societal homogeneity. That these variables may influence combat behavior is borne out by the research of Henderson[8] which concluded that "a nation's potential for nationalism and ultimately for cohesion in its army is indicated by the degree to which a common race and common religion (as well as a common language, culture, and history) are present."

Within the **armed forces-wide esprit de corps** rubric, panel members agreed that levels of Battlefield Experience, Military Tradition, and Troop Commitment were factors that would impact a force's capability to inflict casualties. Two measures of Battlefield Experience that were judged to be of varying importance were number of recent engagements (last 10 years) and number of near-recent engagements (last 25 years). Research by Kellet[6] cites the critical roles that training and leadership play in combat motivation. Recent battle experience, in the panelists' opinion, would increase the likelihood

that the positive effects of experience and combat leadership would be manifested on the battlefield. In the Military Tradition subcategory, the variables of combat success percentage and combat history (# of engagements last century) were judged by the panelists to have varying influences on the fighting spirit of a force. The panel members stated that while recent experience was important to combat motivation, the degree of battlefield success as well as a nation's longer term military history would also be important to combat morale -- the logic being that victories in recent combat operations and a long-standing tradition of battle would increase the motivation of a present-day force. Lastly, two variables that fell under the Troop Commitment subcategory were seen as impacting troop motivation, and potentially, the numbers of casualties a force might inflict: length of conscription and national defense spending priority. Longer conscription periods were seen by the panel as providing a nation greater opportunities for training and instillment of ideology -- two factors judged to affect combat motivation.[9] Defense spending priority, quantified as defense dollars divided by gross domestic product, was judged to impact troop esprit to the extent that the higher the esteem that a nation collectively held its military forces, the more pride that would be manifested by the individual soldiers in performing their duties. Similarly, if a society chose to prioritize its revenue expenditures toward entitlement programs, education, and/or transportation infrastructure, to the detriment of defense spending, then this low defense prioritization was seen by the panelists to potentially have a negative impact on the morale and effectiveness of the individual soldiers.

Data on the nine aforementioned variables, for almost all nations of the world, were found to be available through several reference sources. These data sources were: the *United Nations Statistical Yearbook*,[10] the *Central Intelligence Agency's World Factbook*,[11] *The World Almanac*,[12] and *The Universal Almanac*.[13]

Each member of the SME panel then ranked each factor's importance, overall and relative to the other factors, by assigning each factor a number between 1 and 7 denoting its contribution to battlefield performance. The values obtained from each panelist were then

summed within the individual variables, and these sums divided into the Grand Total of all variables combined. The derived percentages, reflective of each variable's perceived contribution to combat motivation/performance, are displayed in Figure 3.

The panel also was in agreement that factors pertaining to the 'primary group', or the individual combat unit, were important to predicting battlefield performance. Specific primary group factors cited by the SME panel included horizontal bonding (level of camaraderie among peers), vertical bonding (relationships between officers and enlisted), discipline, loyalty, leadership, mental competence, and training. Unfortunately, reliable data on these variables would be extremely difficult to obtain for the armed forces of potential adversaries.

INTRA-VARIABLE WEIGHTINGS

For each of the societal factors, the SME panel also reached consensus on the best method to weight the intra-variable values. Specifically, at issue was how to determine the appropriate weightings of values within each variable; for example, should a country with four recent combat engagements receive twice the score on this variable as a country with only two engagements? An alternative weighting schema would be to weight intra-variable values in a non-linear fashion -- two engagements might be scored as twice that of a single engagement, but a 'ceiling effect' may exist where additional engagements do not add appreciably to the performance benefits derived from the initial two engagements.

For the ethnic homogeneity variable, the panelists agreed upon a scale in which societies having a large degree of homogeneity would likely outperform their ethnically heterogeneous battlefield opponents in a nonlinear fashion. That is to say, societies with high degrees of ethnic homogeneity would likely exhibit a cohesiveness disproportionate to a simple, linear percentage comparison with an adversary having a low degree of homogeneity. As such, in order to incorporate a perceived cohesion advantage of a large ethnic majority, a nation with a single ethnic group composing 80-89% of the population was weighted 25% higher than percentages lower than 80%. Similarly, an ethnically homogeneous society, in which a

single, ethnic majority composed 90% or more of the population, received a weight 50% greater than their actual homogeneity percentage. All scores were then divided by 1.5 to normalize to a 1.0 scale. By example, three scores are shown:

Nation X has an ethnic majority which comprises 60% of its population
Nation Y has an ethnic majority which comprises 84% of its population
Nation Z has an ethnic majority which comprises 95% of its population
Nation X ***ethnhom*** *score = (.6*1.0)/1.5 = 0.4*
Nation Y ***ethhom*** *score = (.84*1.25)/1.5 = 0.7*
Nation Z ***ethhom*** *score = (.95*1.5)/1.5 = 0.95*

Under this scoring system the panelists gave additional weight to the anticipated battlefield performance of those nations which had the highest levels of societal homogeneity. This concept of higher degrees of nationalism and military cohesion being associated with increased levels of societal homogeneity is discussed in the work of Henderson.[8] These same weights (1.0, 1.25, 1.5) were applied similarly to adjust for the varying degrees of religious homogeneity across nations.

For the variables length of conscription, defense spending priority, and per capita electrical consumption, the panelists agreed that linear weighting was appropriate. For example, a country with a conscription term twice that of another received two times the other's score when normalized to a 1.0 scale. For example:

Nation X has a length of conscription of 30 months
Nation Y has a length of conscription of 60 months
Nation Z has the longest term any of the nations at 78 months
Nation X ***lngthconsc*** *score = 30/78 = .385*
Nation Y ***lngthconsc*** *score = 60/78 = .769*
Nation Z ***lngthconsc*** *score = 78/78 = 1.0*

The SME panelists did not believe that a straight linear relationship necessarily held true for the variables reflecting battlefield experience (10 years, 25 years, and the last 100 years). In the instance of recent battlefield experience (number of engagements last 10 years), the panelists individually assigned a positive numerical score to each of the five observed values -- 0 engagements, 1 engagement, 2, 3, or 4 engagements. For illustrative purposes, one respondent assigned respective values of 1.0, 2.5, 3.5, 4.3, and 5.0, reflecting the belief that each additional engagement contributed to the expected battlefield performance of a future engagement. A second respondent respectively assigned the values of 1,4,6,7,7 to 0 - 4 engagements, indicating the belief that one engagement contributed substantially to performance when contrasted with zero engagements, but that a fourth engagement did not augment performance over that expected from three previous engagements. Each of the SME member's individual ratings was then divided into his maximum assigned value. In the latter example (1,4,6,7,7) this method yielding the following percentages associated with each of 0 - 4 recent engagements: .14 (1/7), .57 (4/7), .85 (6/7), 1.0 (7/7), and 1.0 (7/7). The other panelist's scores were similarly derived and these values were then averaged across respondents yielding the following mean weights for recent battlefield experience:

0 engagements = .23

1 engagement = .59

2 engagements = .75

3 engagements = .86

4+ engagements = 1.0

The same methodology was utilized to score number of near recent engagements (last 25 years), combat history (engagements last 100 years) and success percentage (number of decisive victories divided by the number of clear engagement outcomes). In each case, the SME panelists were provided with the maximum number of engagements documented for the nations, so that their ratings could encompass the entire spectrum possible. The panel's average weightings for the possible values within these three variables were:

ENGAGEMENTS 11-25 yrs	ENGAGEMENTS 26 - 100 yrs	SUCCESS % (0-25 yrs)
0 engagements = .20	0 engagements = .12	0% = .30
1 engagement = .47	1 engagement = .19	1% - 13% = .36
2 engagements = .64	2 engagements = .20	14% - 27% = .53
3 engagements = .55	3 engagements = .21	28% - 41% = .56
4 engagements = .52	4 engagements = .22	42% - 56% = .68
5 engagements = .51	5 engagements = .22	57% - 70% = .69
6 engagements = .51	6 engagements = .23	71%+ = .93
7+ engagements = .52	7 engagements = .24	
	8 engagements = .24	
	9+ engagements = .25	

COMPUTING THE COMPOSITE SOCIETAL FACTORS SCORE

The first step performed in deriving the Composite Societal Factors scores for various nations was assessing which societal variables were likely to impact battlefield performance, as well as their relative impacts on performance. These variables and weights were discussed earlier and are depicted in Figure 3. The second step taken was to weight the individual values that might be observed for the selected variables; this was discussed in the preceding section and involved determining whether values should be weighted linearly or nonlinearly, and included normalization to the maximum value observed across nations. The last step then was to multiply the component factor weights (step 1) by the intra-variable value weightings (step 2) and sum these products for each individual nation. An example for one potential adversary follows:

COMPONENT FACTOR	WEIGHT	VALUE NATION X	MAX. VALUE	ADJUSTMENTS FOR MAXIMUM AND WEIGHT		NATION X SCORE
Ethnic homogeneity	*15%*	*0.90*	*1.5*	*((.90*1.5)/1.5)*.15*	=	*.135*
Religious homogeneity	*12%*	*0.74*	*1.5*	*((.74*1.0)/1.5)*.12*	=	*.059*
Elect consump/capita	*10%*	*0.067*	*1.1*	*(.067/1.10)*.10*	=	*.006*
*Defense/GNP*100*	*11%*	*2.96*	*18.03*	*(2.96/18.03)*.11*	=	*.018*
Conscription (months)	*6%*	*30*	*78*	*(30/78)*.06*	=	*.023*
Engagements 10 yrs	*18%*	*0*	*1.0*	*(.23/1.0)*.18*	=	*.041*
Engagements 11-25 yrs	*9%*	*4*	*.64*	*(.52/.64)*.09*	=	*.073*
Engagements 26-100 yrs	*8%*	*3*	*.25*	*(.21/.25)*.08*	=	*.067*
Combat success %	*11%*	*0.33*	*.93*	*(.56/.93)*.11*	=	*.066*
SUM OF COMPONENT SCORES						***0.488***

A final computation was to normalize the value for a potential adversary against that calculated for U.S. forces. If, for instance, the sum of the societal component scores for the U.S. was 0.73, then the above adversary would be expected, based on societal factors scores alone, to have 67% of the battlefield performance of U.S. forces (.488/.730). Thus, the shift in previously observed U.S. casualty sustainment rates, owing solely to differences in societal factors between the U.S. and this adversary, would be -0.33. Composite scores and original societal factor values for the U.S. and 23 potential adversaries are seen in Table 1.

WEAPONS PARITY

Similar to the need to incorporate 'societal factor' adjustments, the FORECAS casualty rate projections required adjustment to reflect the degree of present-day weapons parity between the U.S. and potential adversaries. This task was accomplished in two major phases. The first phase entailed examining the weapons parity between the U.S. and opposing forces during the battles for which empirical casualty data were obtained. Contrasts were made between U.S. and Japanese forces during World War II Pacific operations, between U.S. and Korean forces during the Korean Conflict, between U.S. and North Vietnamese forces during the Vietnam War, and between the United Kingdom and Argentina during the Falklands War. The second phase then required contrasting the present-day weapons inventories of the U.S. with the inventories of potential adversaries.

COMPARING WEAPONS FOR KNOWN CASUALTY RATES

For each historical operation that contributed to the FORECAS casualty projections, the weapons in use by the opposing sides were examined. The various categories of weapons included pistols, rifles, machine-guns, mortar, artillery, and main battle tanks; for the Vietnam War, a weapon category was added for battlefield explosives; also, the use of air-launched weaponry was examined for both the Vietnam and Falklands Conflicts.

U.S. versus Japan

Pistol. The main characteristics contributing to the lethality of pistols during combat were

viewed as the stopping power (caliber of round), feed (number of rounds held by weapon) and muzzle velocity (speed at which round travels). The use of a pistol during combat indicates the need for an immediate halt to an advancing adversary at close proximity; the ability of a pistol to be effective in this circumstance is thought to depend primarily on its stopping power. Feed or the number of rounds that can be consecutively fired, without stopping to reload, also contributes to pistol lethality. To a lesser extent, muzzle velocity also has an impact on pistol lethality in a combat scenario.

The United States mainly used the Model 1911A1 .45 Colt Automatic pistol during WWII. The Model 1911A1 fired a 45 caliber round, held a total of 7 rounds and traveled at 245 meters per second.[14,15] Japan's main pistol was the Nambu, Type 14 which fired a 30 caliber round, held a total of 8 rounds and traveled at a rate of 324 meters per second.[14,16]

Stopping power, which was judged to be the main determinant in assessing pistol lethality, has been assigned a weight of .75 (75%) for its proportional contribution to lethality. Feed has been weighted at .20 (20%) for its contribution, while muzzle velocity rated a weight of only .05 (5%). The United States was judged to have a more lethal military pistol than the Japanese during WWII due to its superior stopping power (see Table 2).

Rifle. The main characteristics contributing to the lethality of rifles during combat were viewed to be the feed (number of rounds held by weapon), stopping power (caliber of round) and effective range (maximum range in combat). The rifle is designed to hit stationary or moving targets at a much greater distance than pistols; the ability of a rifle to be effective is thought to depend almost equally on feed, stopping power and effective range.

The United States mainly used the M1 Carbine which held fifteen 30 caliber rounds and had an effective range of 300 meters.[14,15] Japan's main rifle was the Type 99 which held five 30 caliber rounds with an effective range of 300 meters.[14,15]

Feed, which was judged to be the main determinant in assessing rifle lethality, has been

assigned a weight of .40 for its contribution; stopping power has been weighted at .35 and effective range has been weighted at .25 for their contributions to rifle lethality. The United States was judged to have a more lethal rifle than Japan during WWII mainly due to its advantage in feed (see Table 3).

Machine-Gun. The main characteristics contributing to the lethality of machine-guns during combat were viewed to be the cyclic rate (rate at which rounds are fired from the weapon), stopping power (caliber of round) and muzzle velocity (the speed at which the round travels). The use of a machine-gun in combat indicates the need of fire support in stopping large adversarial troop advancements; the ability of a machine-gun to be effective under these circumstances is thought to depend primarily on cyclic rate and stopping power. To a lesser extent, muzzle velocity also has an impact on machine-gun lethality.

The United States mainly used the Browning Automatic Rifle (BAR) which fired 30 caliber rounds at a cyclic rate of 500 rounds per minute and traveled at 853 meters per second.[15] The Japanese machine-gun, Type 99, also fired 30 caliber rounds at a cyclic rate of 500 rounds per minute but traveled at a speed of 732 meters per second.[14]

Cyclic rate and stopping power, which were judged to be the main determinants in assessing machine-gun lethality, has each been assigned a weight of .40 for their contributions to weapon lethality; muzzle velocity has been weighted .20 for its contribution. The United States was judged to have a slightly more lethal machine-gun than Japan during WWII mainly due to its narrow edge in muzzle velocity (see Table 4).

Mortar. The main characteristics contributing to the lethality of mortars during combat were viewed to be the range (distance fired round travels), weight (carrying weight of weapon) and caliber (size of round). The mortar is designed to provide portable high-angle fire support (to reach behind high cover) and provide short range high firepower, smoke or battlefield illumination. The ability of a mortar to be effective is thought to depend primarily on its

range and weight. To a lesser extent, caliber also has an impact on mortar lethality in combat.

The United States mainly used the M29 mortar which had a range of 3350 meters, weighed 52.2 kilograms and fired an 81mm caliber round.[17] The Japanese mortar, Model 97, had a range of 3100 meters, weighed 65.9 kilograms and fired an 81mm caliber round.[17]

Range and weight, which were judged to be the main determinants in assessing mortar lethality, have been assigned weights of .40 for their contributions to weapon lethality while caliber has been weighted at .20. The United States was judged to have a more lethal mortar than Japan during WWII mainly due to its advantage in range and weight (see Table 5).

Artillery. The main characteristics contributing to the lethality of artillery during combat were viewed to be the range (distance round travels), rate of fire (number of rounds launched per unit time) and caliber (size of round). Artillery's prime task is to destroy distant targets and provide long range fire power. The ability of artillery to be effective is thought to depend mainly on its range and rate of fire. To a lesser extent, caliber also has an impact on artillery lethality in combat.

The United States generally used the M1A1, which had a range of 8500 meters, a rate of fire of 22 rounds per minute and a caliber of 75mm.[18] Japan used the Type 94 which had a range of 8320 meters, a rate of fire of 10-12 rounds and a caliber of 75mm.[18]

Range and rate of fire, which were judged to be the main factors in assessing artillery lethality, have each been weighted at .40 for their respective contributions to artillery lethality. Caliber has been weighted as making a 20% contribution to artillery lethality. The United States was judged to have a more lethal artillery than Japan during WWII mainly due to its advantage in range and rate of fire (see Table 6).

Main Battle Tank. The main characteristics contributing to the lethality of a main battle tank were viewed to be armor thickness (thickness of armor protection), speed (miles per hour tank can travel) and main armament (stopping power of main armament). The main battle tank's prime task is to overrun fortified positions and counter adversarial armor; the ability of a main battle tank to be effective is thought to depend primarily on its armor thickness. The speed that the main battle tank can travel also contributes to lethality. To a lesser extent, the main armament also has an impact on main battle tank lethality.

The United States used the M4 Sherman which had an armor thickness of 75mm, a maximum speed of 24 miles per hour and a main armament caliber of 76mm.[19] The Japanese main battle tank, Type 97, had an armor thickness of 30mm, a maximum speed of 24 miles per hour and a main armament caliber of 75mm.[19]

Armor thickness was judged to be the main determinant in assessing tank lethality and was assigned a weight of .60 for its contribution to lethality; speed was weighted at .25 and main armament has been weighted at .15 for their contributions. The United States was judged to have a more lethal main battle tank than Japan during WWII mainly due to its advantage in armor thickness (see Table 7).

U.S. versus Korea

Pistol. The United States generally used the Model 1911A1 .45 Colt Automatic pistol during the Korean War. The Model 1911A1 fired a 45 caliber round, held a total of 7 rounds and traveled at 245 meters per second.[14,15] The Korean's main pistol was the TT33 Tokarev which fired a 30 caliber round, held a total of 8 rounds and traveled at a rate of 420 meters per second.[14,20] The United States was judged to have a more lethal military pistol than the Koreans during the Korean War due to its superior stopping power. Even though the Korean pistol possessed an extra round and had greater muzzle velocity, the American pistol was rated more lethal due to its advantage in stopping power (see Table 8).

Rifle. The United States mainly used the M1 Carbine which held fifteen 30 caliber rounds and had a combat range of 300 meters.[14,15] Korea's main rifle was the Nagant M1891/30 which held five 30 caliber rounds with an effective range of 300 meters.[20] Even though the Korean rifle was equal in stopping power and combat range, the three-fold U.S. advantage in feed was the main factor in assigning the United States an advantage in rifle lethality (see Table 9).

Machine-Gun. The United States generally used the Browning Automatic Rifle (BAR) which fired 30 caliber rounds at a cyclic rate of 500 rounds per minute and traveled at 853 meters per second.[20] The Korean machine-gun, AK47, also fired 30 caliber rounds at a cyclic rate of 600 rounds per minute but traveled at a speed of 710 meters per second.[20,21] The North Koreans were judged to have a more lethal machine-gun due to its edge in cyclic rate of fire and muzzle velocity (see Table 10).

Mortar. The United States mainly used the M30 mortar which had a range of 5420 meters, weighed 295 kilograms and fired an 107mm caliber round.[17,18] The North Korean mortar, M107, had a range of 6300 meters, weighed 170 kilograms and fired an 107mm caliber round.[17] The North Koreans were judged to have a more lethal mortar due to its advantage in range and weight (see Table 11).

Artillery. The United States generally used the M114A1 which had a range of 14,600 meters, a rate of fire of 2 rounds per minute and a caliber of 155mm.[17,18] The North Koreans used the ML20 which had a range of 17,300 meters, a rate of fire of 4 rounds/minute and a caliber of 152mm.[17] The North Koreans were judged to have a more lethal artillery due to its advantage in range and rate of fire (see Table 12).

Main Battle Tank. The United States mainly used the M47 (Patton), which had an armor thickness of 115mm, a maximum speed of 37 miles per hour and a main armament caliber of 90mm.[19] The Korean main battle tank, T-34/85, had an armor thickness of 60mm, a

maximum speed of 32 miles per hour and a main armament caliber of 85mm.[19] The United States was judged to have a more lethal main battle tank than Korea due to its advantage in armor thickness, speed, and main armament (see Table 13).

U.S. versus Vietnam

Pistol. The United States predominantly used the Model 1911A1 .45 Colt Automatic pistol during the Vietnam war. The Model 1911A1 fired a 45 caliber round, held a total of 7 rounds and traveled at 245 meters per second.[14,15] The Vietnamese main pistol was the TT33 Tokarev which fired a 30 caliber round, held a total of 8 rounds and traveled at a rate of 420 meters per second.[15,20] Even though the Vietnamese pistol possessed an extra round and had greater muzzle velocity, the American pistol was rated more lethal due to its advantage in stopping power (see Table 14).

Rifle. The United States generally used the M14 which held twenty 30 caliber rounds and had a combat range of 300 meters.[20] Vietnam's main rifle was the SKS which held ten 30 caliber rounds with a combat range of 300 meters.[20] The United States was judged to have a more lethal rifle than Vietnam during the Vietnam War mainly due to its advantage in feed. Even though the Vietnamese rifle was equal in stopping power and effective range, the U.S. three-fold advantage in feed was the main determinant in assigning the United States an advantage in rifle lethality (see Table 15)

Machine-Gun. The United States predominantly used the Browning Automatic Rifle (BAR) which fired 30 caliber rounds at a cyclic rate of 500 rounds per minute and traveled at 853 meters per second.[20] The machine-gun used by Vietman, AK47, also fired 30 caliber rounds at a cyclic rate of 600 rounds per minute but traveled at a speed of 710 meters per second.[20] The United States was judged to have a slightly more lethal machine-gun than Vietnam during the Vietnam War mainly due to its advantage in muzzle velocity (see Table 16).

Mortar. The United States generally used the M2 mortar which had a range of 4022 meters, weighed 151 kilograms and fired an 107mm caliber round.[20] The North Vietnamese mortar, M1938, had a range of 6300 meters, weighed 170 kilograms and fired an 107mm caliber round.[20] The North Vietnamese were judged to have a slightly more lethal mortar during the Vietnam War due to its advantage in range (see Table 17).

Artillery. The United States was able to use the UH-1B Helicopter[22] to launch artillery at the Vietnamese, whom did not possess the same capability. The United States main artillery type was the M2 SP which had a range of 23,500 meters, a rate of fire of 1 round per minute and a caliber of 155mm.[18,22] The North Vietnamese used the ML20 which had a range of 17,300 meters, a rate of fire of 4 rounds per minute and a caliber of 152mm.[18,22] Airborne delivery utilization, range and rate of fire, which were judged to be the main determinants in assessing artillery lethality, have respectively been weighted .35, .25, .25, for their overall contributions to lethality; caliber has been weighted at .15 for its contribution. The United States was judged to have a more lethal artillery than Vietnam during the Vietnam War mainly due to its advantage in airborne delivery utilization (see Table 18).

Battlefield Explosives. The main characteristic contributing to the lethality of battlefield explosives was thought to be its relative utilization. Utilization of unconventional explosives (booby traps) was given a weight of .40 in this weapons category for it's contribution to lethality while grenades and mines were both assigned a weight of .30. Vietnam was judged to have more lethal battlefield explosives than the United States mainly due to its advantage in the use of unconventional explosives (see Table 19).

Main Battle Tank. The United States used the M60 which had an armor thickness of 75mm, a maximum speed of 30 miles per hour and a main armament caliber of 105mm.[20] The North Vietnam main battle tank, T-34/85, had an armor thickness of 60mm, a maximum speed of 32 miles per hour and a main armament caliber of 85mm.[20] The United States was judged to have a more lethal main battle tank than Vietnam during the Vietnam War mainly due to

its advantage in armor thickness and to a lesser extent to the greater size caliber of its main armament (see Table 20).

Air-launched weaponry. The U.S. had clear air superiority over its adversary in the Vietnam Conflict. As a result, the U.S. was able to make extensive use of air-launched bombs and gunfire from platforms such as the B-2 bomber, fighter aircraft, and helicopter gunships. The only relevant characteristic in contrasting lethality within this weapon category was utilization. As the U.S. adversary neither possessed nor utilized air-launched weaponry, Vietnam received a rating of 0.001 when contrasted with the U.S. value of 1.0.

United Kingdom versus Argentina

Small arms. The U.K. and the Argentines were viewed to have weapons of approximately equal lethality within the small arms category. Machine guns received 50% of the weight in this weapon category, while rifle were weighted 45%, and the little-used pistols, 5%. The lethality ratio for the Argentine adversary was rated at 1.0 for small arms when compared with the same weapons for the U.K. (see Table 21)

Mortar. The British mainly used the 81 mm L16A2 mortar which had a range of 6179 meters, weighed 38 kilograms and fired an 81mm caliber round.[23] The Argentine mortar, 81 mm LR FMK2 Mod 0, had a range of 4000 meters, weighed 40.5 kilograms and fired an 81 mm caliber round.[23] Range and weight, which were judged to be the main determinants in assessing mortar lethality, have been assigned a weight of .40 for their respective impacts on lethality, while caliber has been weighted as .20. The British were judged to have a more lethal mortar than the Argentinians due mainly to its advantage in range and weight (see Table 22).

Artillery. The British generally used the Light Gun which had a range of 17,200 meters, a rate of fire of 8 rounds per minute and a caliber of 105mm.[18,23] The Argentines used the M101, which had a range of 15,300 meters, a rate of fire of 8 rounds/minute and a caliber of

105mm.[18,23] Range and rate of fire, which were judged to be the main determinants in assessing artillery lethality, have each been weighted as .40, while caliber has been weighted at .20. The British were judged to have a more lethal artillery than the Argentines mainly due to its advantage in range (see Table 23).

Air-launched weaponry. While the Argentines were able to exploit a lack of air superiority by the British in the early days of the Falklands Conflict, the U.K. gained control of the skies less than midway through the operation. For this reason, the adversary rating within the air-launched weaponry category was judged to be .50 when contrasted with the 1.0 score for the U.K.

Having contrasted weapons lethality among opposing forces for the various arms categories, it was then important to assign weights for the relative impact of these weapons on casualty sustainment. For example, though a U.S. adversary might possess a superior model of rifle, if relatively few battlefield casualties were incurred as a result of rifle fire, this weapon superiority would have but a minor impact on casualty sustainment. Accordingly, each weapon needed to be weighted as to their impact on overall casualties sustained. The relationship between each weapon and its impact on overall casualties may be thought of as a "casualty sustainment index" (CSI); CSI values, summing to 1.0, were assigned for each weapon, proportional to the importance that that weapon played in the WIA and KIA incidence during that individual conflict. For example in the Okinawa land operation, artillery, mortar, and tanks were judged to have the greatest impact on casualty sustainment and were weighted accordingly (.39, .18, .175, respectively). Tables 24 - 27 display the weapons' casualty sustainment indices for the combat operations (Okinawa, Korea, Vietnam, and the Falklands) underlying the baseline FORECAS projections. Also included in these tables are the previously discussed adversary ratings for each weapon and the overall weapons parity score for each operation.

PRESENT-DAY WEAPONRY COMPARISONS

The next step in adjusting FORECAS casualty projections was to compare the degree of

weapons parity from previous operations with the parity among the U.S. and potential present-day adversaries. In order to do this, various weapons likely to impact the casualties sustained by U.S. ground forces were examined. Specifically, four categories of modern weapons were focused upon for the U.S. and potential adversaries: artillery, armor, infantry weapons, and airborne attack & detection. Reference sources used to determine technology level and numbers of weapons possessed included *Jane's Armour and Artillery*,[24] *Jane's Infantry Weapons*,[25] *Jane's Weapon Systems*,[26] *Jane's Radar and Electronic Warfare Systems*,[27] *Jane's Battlefield Surveillance Systems*,[28] *Modern Land Combat*,[23] *Conduct of the Persian Gulf War*,[29] *Desert Score*,[30] and *Witness to War*.[31]

Artillery

Contemporary artillery plays a considerable role in land combat and has been termed "the greatest killer on the battlefield".[32] Artillery possessed by the U.S. and potentially opposing forces has been examined within the subcategories of towed artillery, self-propelled artillery, and multiple launched rocket systems (MLRS), as well as in terms of overall pieces. Each nation was assigned a 'state of the art' value for the level of technology (age, capabilities) of their artillery pieces within these categories. State of the art values were computed as a percentage of the highest levels of technology documented in the afore-mentioned reference sources. Similarly, a value proportional to the number of total artillery pieces in a nation's arsenal has been computed using 100,000 pieces as a ceiling value; nations with 2500, 83,000 and 110,000 artillery pieces would receive respective values of .025, .830, and 1.0 ratings within the artillery pieces category. Table 28 is a presentation of the technology ratings for the three subcategories of artillery and for total artillery pieces. Also included in Table 28 are the weights assigned for each subcategory's proportional impact on the casualty sustainment caused by artillery, and the overall artillery score.

Armor

The subcategories to be evaluated within the Armor category include main battle tanks, armored personnel carriers, and armored reconnaissance vehicles. State of the art ratings

were assigned for the hardware possessed by each nation within these subcatgories; as with the artillery ratings, armor technology ratings were expressed as a percentage of the highest levels of technology detailed in the weapons reference sources. A fourth subgrouping used for contrasting levels of present-day weapons parity was total number of armor pieces possessed by each nation; this rating was computed as number of armor pieces divided by 10,000 yielding values of .119, .046, and 1.0 for nations that possessed 1190, 455, and 18,500 pieces respectively. Table 29 presents the values for nations within the four armor subcategories, the weights assigned to each subcategory for its contribution to casualty sustainment caused by armor, and the overall armor scores for various nations.

Infantry

Infantry weaponry has improved over the years but still remains largely unaffected by the types of large-scale technological advances that have been seen in other weapon systems. The subgroupings within the Infantry weapon category consisted of machine guns, mortar, anti-tank weapons, close support weapons, submachine guns, and rifles. State-of-the-art ratings were assigned for each of these infantry weapons to represent the levels of technology (age, capabilities) possessed by various nations. Table 30 displays the overall infantry scores, the subcomponent state-of-the-art ratings, and the weight assigned to represent each subcategory's contribution to the casualties induced by infantry weapons.

Airborne Attack and Detection

The final weapons group evaluated for U.S. forces and potential adversaries as to its potential impact on U.S. ground casualty sustainment was the category of Airborne Attack & Detection. This category includes ratings of fixed wing attack aircraft, attack helicopters, land attack missiles, radar, and electronic countermeasures. State-of-the-art ratings, quantified as a percentages of the highest technology available, were assigned for attack aircraft, missiles, radar, and electronic warfare sophistication. Additionally, ratings for the degree of numerical parity for attack planes and helicopters among nations were both computed as percentages as the number of aircraft divided by 10,000. The overall Airborne

Attack & Detection scores, as well as the ratings for components within this category and the assigned subcategory weights, are seen in Table 31.

RELATIVE WEIGHTS

A last step in quantifying the potential impact of present-day weaponry on U.S. casualty rates was to assign relative weights to each individual weapon category. This required an assessment of the relative contributions of opposing side's artillery, armor, infantry weapons, and airborne attack and detection measures on the casualties incurred by U.S. forces. While none of these types of weaponry are used as stand-alone systems in combat they all have their unique impacts on casualties sustained.

In a ground action, the Airborne Attack & Detection category, which included attack aircraft, land attack missiles, radar, and electronic warfare, was judged to have the greatest impact on potential U.S. casualty sustainment among the four weapons categories. This category was weighted at 45% of the overall weapons impact on casualty sustainment because the high technology within this category can both inflict many casualties and preempt casualty sustainment by an opposing force. A large advantage in this weapon category would be expected to contribute to greater casualty minimization than the other three arms categories.

The presence of the different types of artillery -- towed, self-propelled, and multiple launched rocket systems (MLRS) -- as well as the number of artillery pieces that opposing forces possess, can greatly impact the incidence of WIA and KIA among ground forces. Contemporary artillery, therefore, was weighted at 25% of the overall weapons influence on the numbers of casualties sustained by a force. Armored vehicles, such as main battle tanks, personnel carriers, fighting vehicles (e.g., the M2A2 Bradley Fighting Vehicle) and reconnaisance vehicles were also rated to have a substantial impact on battlefield casualty sustainment. Accordingly, armor has been weighted at 20% for its relative contribution to weapons-related casualty sustainment. The last category of arms, infantry weapons, was judged to have a relatively small impact on casualty sustainment when contrasted with

artillery, armor, and airborne attack weaponry. The influence of infantry weapons, which included mortars, anti-tank weaponry, close support weapons, sub-machine guns, and rifles was weighted at 10% of the overall weapons impact on casualty sustainment.

PRESENT-DAY WEAPONS SCORES

Each individual weapons category weight was then multiplied by the weapons category composite score and the products across the four arms categories were summed. This calculation yielded the overall weapons rating scores presented in Table 32. These ratings represent the degree of casualty-related weapons parity between the U.S. and twenty-three potential adversaries. Present-day weapons parity between opposing forces must then be contrasted with the weapons parity of the historical operations in order to make adjustments to future casualty sustainment.

DISCUSSION

The FORECAS casualty projection planning tool was designed to project the numbers of WIA, KIA, and DNBI likely to be incurred among Marines during ground combat operations. The basis for these projections was the casualty sustainment trends observed during previous ground operations: U.S. deployments to Okinawa, Korea, and Vietnam, as well as the U.K. deployment to the Falklands. Operation DESERT STORM, however, underscored that resistance mounted by future opposition forces may not always parallel that evidenced in previous operations. Consequently, the present endeavor sought to quantify the adjustments required to the baseline casualty projections to more accurately reflect the numbers of WIA and KIA likely to be incurred with specific potential adversaries.

Adversary-specific adjustments were made to reflect the degrees of parity between U.S. forces and potential enemy forces within two domains: 1) measures underlying an armed forces' combat motivation, and 2) a military's weapons capabilities. A Subject Matter Expert (SME) panel was assembled to specify societal variables that might be reflective of

motivational factors and to reach consensus on how these factors might most appropriately be weighted. Societal factors selected included battlefield experience, societal homogeneity, defense spending priority, and technological sophistication.

In addition to societal-level indicators of cohesion and motivation, the SME panel was unanimous in their agreement that group-level (battalion, company) measures of cohesion would impact battlefield performance and an opposition force's ability to inflict casualties on U.S. forces. Unfortunately, obtaining accurate unit-level data on degree of bonding, discipline, loyalty, leadership, etc. for opposition forces would be a near-impossible undertaking.

Contrasts were also performed between the weapons inventories of the U.S. and potential adversaries. Using unclassified sources,[14-31] present-day weapons capabilities of the U.S. and other nations were quantified, as were the weapons capabilities between forces of the baseline combat engagements (Okinawa, Korea, Vietnam, Falklands). Armaments were quantified in terms of level of technology and the quantities within four weapons categories: infantry, armor, artillery, and attack aircraft and detection hardware.

Composite weapons' scores and societal factors' scores were computed for the U.S. and twenty-three potential adversaries. FORECAS casualty projections will now incorporate the degrees of present-day weapons parity and motivational parity between opposing forces. This approach allows the robustness of the empirical casualty data to be retained, while at the same time making adjustments neccesary to reflect contemporary adversaries.

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FIGURE 1. POTENTIAL SOCIETAL FACTORS AFFECTING BATTLEFIELD PERFORMANCE AS PRESENTED TO SUBJECT MATTER EXPERT PANEL

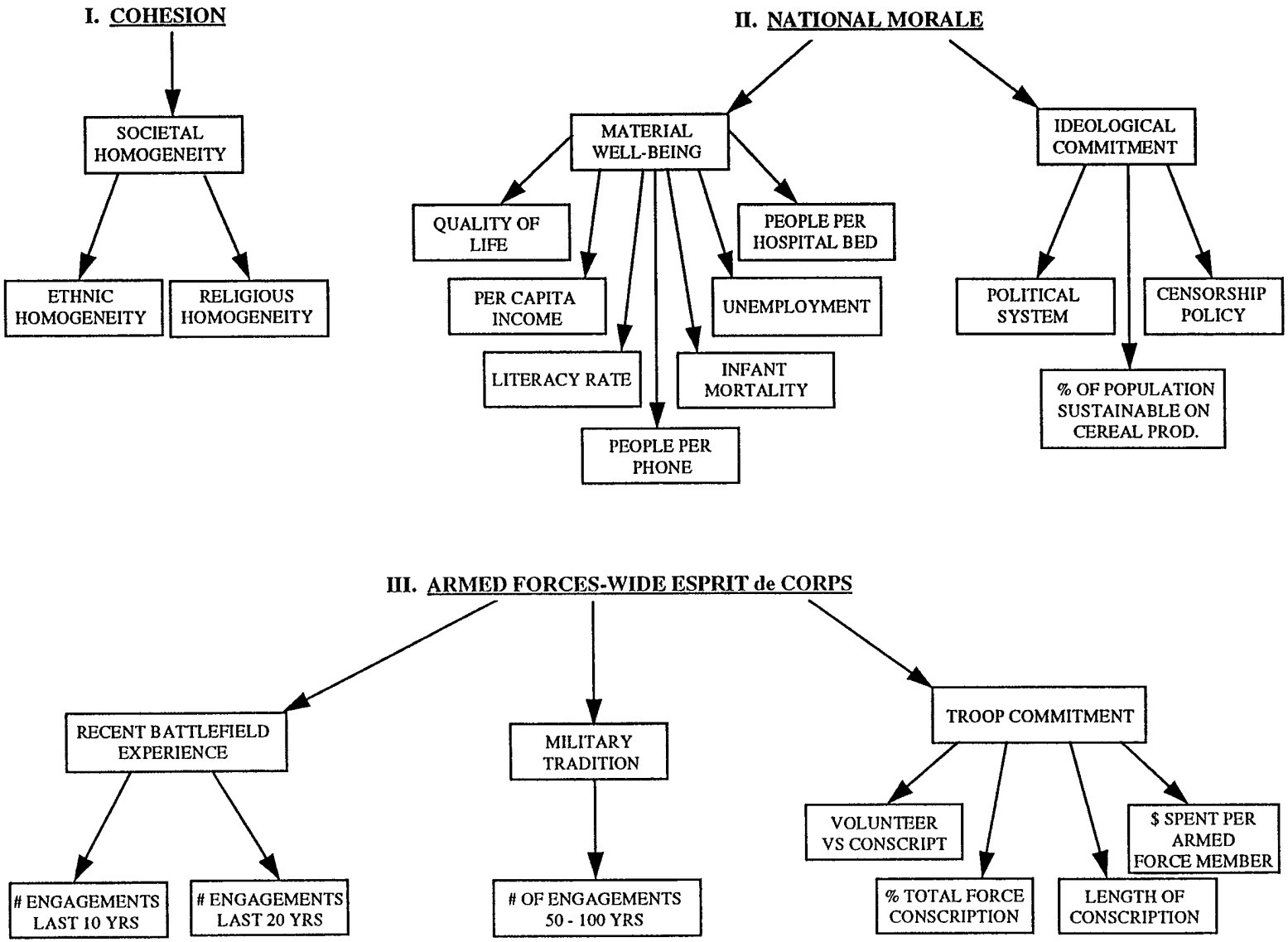

FIGURE 2. BEHAVIORAL CONSTRUCTS AFFECTING BATTLEFIELD PERFORMANCE AND SOCIETAL FACTORS CHOSEN BY SUBJECT MATTER EXPERT PANEL AS REFLECTIVE OF THESE CONSTRUCTS

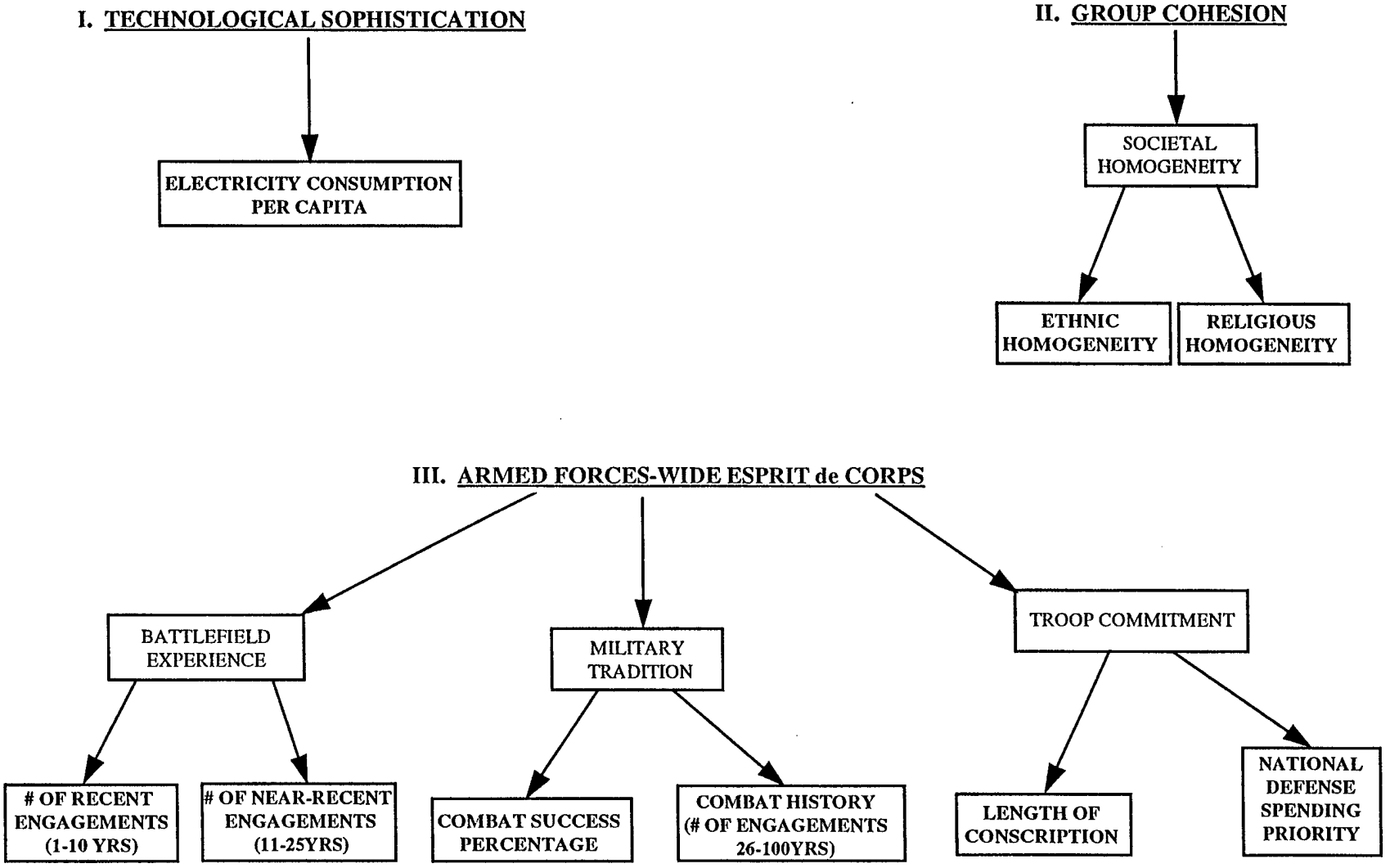

FIGURE 3. RELATIVE WEIGHTS COMPUTED FROM SME RATINGS OF SOCIETAL FACTOR IMPACTS ON BATTLEFIELD PERFORMANCE

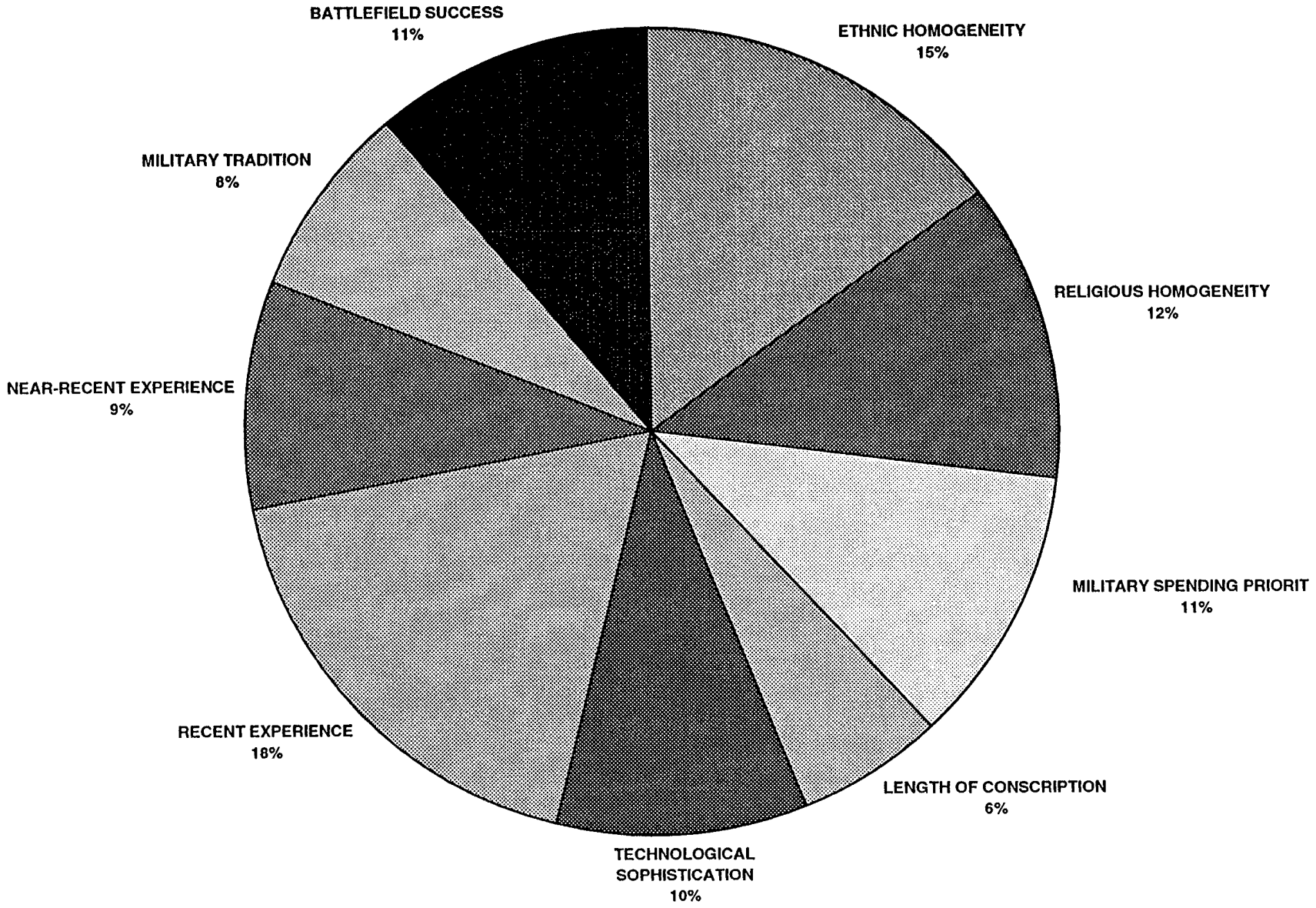

TABLE 1. SOCIETAL FACTOR COMPONENT VALUES AND COMPOSITE SCORES FOR U.S. AND POTENTIAL ADVERSARIES

NATION	ETHNIC HOMOGENIETY	RELIGIOUS HOMOGENIETY	ELECT CONSUMP/ CAPITA	DEFENSE/ GNP*100	CONSCRIPTION (MONTHS)	ENGAGEMENTS 10 YRS	ENGAGEMENTS 11-25 YRS	ENGAGEMENTS 26-100 YRS	COMBAT SUCCESS %	COMPOSITE SCORE
1	0.38	0.84	0.004	15.00	48	5	2	1	N/A	0.65
2	0.95	0.70	0.093	0.34	24	0	0	2	N/A	0.41
3	0.99	0.99	0.000	1.40	18	1	0	1	N/A	0.54
4	0.37	0.47	0.016	18.03	24	3	1	2	1.00	0.60
5	0.85	0.85	0.576	1.07	18	0	0	3	N/A	0.45
6	0.92	N/A	0.087	0.22	24	1	1	10	1.00	0.60
7	0.51	0.85	0.001	4.29	24	2	1	2	N/A	0.50
8	0.78	0.78	N/A	6.26	26	0	1	0	0.01	0.42
9	0.72	0.80	0.012	0.62	25	1	1	2	1.00	0.52
10	0.51	0.99	0.019	4.19	24	1	0	0	1.00	0.50
11	0.78	0.97	0.004	7.11	24	2	2	2	0.25	0.61
12	0.90	0.95	0.001	1.33	60	0	2	1	0.50	0.58
13	0.97	0.97	N/A	10.03	36	1	0	1	0.01	0.65
14	1.00	N/A	0.128	10.33	78	0	0	1	N/A	0.54
15	0.64	0.77	0.022	1.32	25	0	1	1	0.01	0.36
16	0.89	0.80	0.086	3.00	12	0	0	3	N/A	0.41
17	0.82	0.60	0.713	9.98	18	2	0	5	0.01	0.56
18	N/A	0.60	0.085	1.65	12	1	1	2	N/A	0.42
19	0.52	0.70	0.004	2.53	25	1	1	0	N/A	0.40
20	0.90	0.74	0.068	2.96	30	0	4	3	0.33	0.49
21	0.98	0.98	0.001	1.67	12	0	0	0	N/A	0.50
22	0.83	0.56	1.100	4.22	50	3	2	3	0.75	0.73
23	0.88	N/A	0.010	0.52	36	0	4	2	1.00	0.49
24	N/A	N/A	0.395	N/A	12	1	0	4	1.00	0.58

TABLE 2. PISTOL LETHALITY FACTOR COMPONENTS; WWII

CHARACTERISTIC (value)	U.S. specifications	JAPAN specifications	ADVERSARY RATING (U.S. =1.0)
STOPPING POWER (.75)	45 CALIBER	30 CALIBER	.67
FEED(ROUNDS) (.20)	7	8	1.14
MUZZLE VELOCITY (.05)	245 m/s	324 m/s	1.3

LETHALITY RATIO = CHARACTERISTIC(value) x ADVERSARY RATING
= (.75x.67)+(.20x1.14)+(.05x1.3)
= **.80**

SUMMARY AND EXPLANATION: U.S.A. pistols were judged to have 1.5 times the stopping power of Japanese pistols. The extra round in the Japanese pistol was judged to give it a 20% advantage in that area. Increase in muzzle velocity of the Japanese pistols gives it a 30% advantage in this area.
Stopping power is the overriding factor in determining lethality of pistols.

U.S. was rated at 1.0 for all factors and provides the standard against which other countries were measured.

TABLE 3. RIFLE LETHALITY FACTOR COMPONENTS; WWII

CHARACTERISTIC (value)	U.S. specifications	JAPAN specifications	ADVERSARY RATING (U.S. =1.0)
FEED(ROUNDS) (.40)	15	5	.3
STOPPING POWER (.35)	30 CALIBER	30 CALIBER	1.0
EFFECTIVE RANGE (.25)	300 METERS	300 METERS	1.0

LETHALITY RATIO = CHARACTERISTIC(value) x ADVERSARY RATING
= (.40x.3)+(.35x1.0)+(.25x1.0)
= **.72**

SUMMARY AND EXPLANATION: U.S.A. rifles were judged to have equal the stopping power of Japanese rifles. The 10 extra rounds in the U.S.A. rifles was judged to give it a three fold advantage in that area. Effective range of the Japanese rifle is equal to that of the U.S.A. rifle in this area.
Stopping power and Feed are the overriding factors in determining lethality of rifles.

U.S. was rated at 1.0 for all factors and provides the standard against which other countries were be measured.

TABLE 4. MACHINE-GUN LETHALITY FACTOR COMPONENTS; WWII

CHARACTERISTIC (value)	U.S. specifications	JAPAN specifications	ADVERSARY RATING (U.S.=1.0)
CYCLIC RATE (.40)	500 rpm	500 rpm	1.0
STOPPING POWER (.40)	30 CALIBER	30 CALIBER	1.0
MUZZLE VELOCITY (.20)	853 m/s	732 m/s	.86

LETHALITY RATIO = CHARACTERISTIC(value) x ADVERSARY RATING
= (.40x1.0)+(.40x1.0)+(.2x.86)
= **.97**

SUMMARY AND EXPLANATION: U.S.A. machine-guns were judged to have equal the stopping power of Japanese machine-guns. The cyclic rate of fire in the Japanese machine-guns was judged to be equal to the U.S.A. machine-gun in that area. Increase in muzzle velocity of the U.S.A. machine-gun gives it approximately a 10% advantage in this area.

Stopping power and Cyclic Rate of Fire are the overriding factors in determining lethality of machine-guns.

U.S. was rated at 1.0 for all factors and provides the standard against which other countries were measured.

TABLE 5. MORTAR LETHALITY FACTOR COMPONENTS; WWII

CHARACTERISTIC (value)	U.S. specifications	JAPAN specifications	ADVERSARY RATING (U.S. =1.0)
RANGE (.40)	3350m	3100m	.9
WEIGHT (.40)	52.2kg	65.9kg	.8
CALIBER (.20)	81mm	81mm	1.0

LETHALITY RATIO = CHARACTERISTIC(value) x ADVERSARY RATING
= (.40x.9)+(.40x.8)+(.2x1.0)
= **.88**

SUMMARY AND EXPLANATION: U.S.A. mortars were judged to have equal the caliber of Japanese mortars. The weight in the U.S.A. mortars was judged to be less then the Japanese mortars and was judged to give it a 20% advantage in that area. Increase in range of the U.S.A. mortars gives it a 10% advantage in this area.

Range and weight are the overriding factors in determining lethality of mortars.

U.S. was rated at 1.0 for all factors and provides the standard against which other countries were measured.

TABLE 6. ARTILLERY LETHALITY FACTOR COMPONENTS; WWII

CHARACTERISTIC (value)	U.S. specifications	JAPAN specifications	ADVERSARY RATING (U.S. =1.0)
RANGE (.40)	8500m	8320m	.98
RATE OF FIRE (.40)	22rds/min	10-12 rds/min	.5
CALIBER (.20)	75mm	75mm	1.0

LETHALITY RATIO = CHARACTERISTIC(value)x ADVERSARY RATING
= (.40x.98)+(.40x.5)+(.2x1.0)
= **.79**

SUMMARY AND EXPLANATION: U.S.A. artillery were judged to have equal the caliber of Japanese artillery. The range of the U.S.A. artillery was judged to have approximately a 5% advantage over the Japanese artillery in that area. Increase in rate of fire of the U.S.A. artillery gives it a 50% advantage in this area.

Range and Rate of fire are the overriding factors in determining lethality of Artillery.

U.S. was rated at 1.0 for all factors and provides the standard against which other countries were measured.

TABLE 7. MAIN BATTLE TANK LETHALITY FACTOR COMPONENTS; WWII

CHARACTERISTIC (value)	U.S. specifications	JAPAN specifications	ADVERSARY RATING (U.S.=1.0)
ARMOR THICKNESS (.60)	75mm	30mm	.4
SPEED (.25)	24mph	24mph	1.0
MAIN ARMAMENT (.15)	76mm	75mm	.99

LETHALITY RATIO = CHARACTERISTIC(value)x ADVERSARY RATING
=(.60x.4)+(.25x1.0)+(.15x.99)
=**.64**

SUMMARY AND EXPLANATION: The armor thickness of U.S.A. main battle tanks were judged to have a 60% advantage over the Japanese main battle tanks in that area. The speed of the U.S.A. main battle tanks was judged to be equal to the Japanese main battle tanks in that area. The main armament of the U.S.A. main battle tanks was judged to be equal to that of the Japanese main battle tanks.

Armor thickness is the overriding factor in determining lethality of main battle tanks.

U.S. was rated at 1.0 for all factors and provides the standard against which other countries were measured.

TABLE 8. PISTOL LETHALITY FACTOR COMPONENTS; KOREAN WAR

CHARACTERISTIC (value)	U.S. specifications	Korea specifications	ADVERSARY RATING (U.S. =1.0)
STOPPING POWER (.75)	45 CALIBER	30 CALIBER	.67
FEED(ROUNDS) (.20)	7	8	1.14
MUZZLE VELOCITY (.05)	245 m/s	420 m/s	1.7

LETHALITY RATIO = CHARACTERISTIC(value) x ADVERSARY RATING
= (.75x.67)+(.20x1.14)+(.05x1.7)
= **.82**

SUMMARY AND EXPLANATION: U.S.A. pistols were judged to have 1.5 times the stopping power of Korean pistols. The extra round in the Korean pistol was judged to give it a 20% advantage in that area. Increase in muzzle velocity of the Korean pistol gives it a 70% advantage in this area.
Stopping power is the overriding factor in determining lethality of pistols.

U.S. was rated at 1.0 for all factors and provides the standard against which other countries were measured.

TABLE 9. RIFLE LETHALITY FACTOR COMPONENTS; KOREAN WAR

CHARACTERISTIC (value)	U.S. specifications	KOREA specifications	ADVERSARY RATING (U.S. =1.0)
FEED(ROUNDS) (.40)	15	5	.3
STOPPING POWER (.35)	30 CALIBER	30 CALIBER	1.0
EFFECTIVE RANGE (.25)	300 METERS	300 METERS	1.0

LETHALITY RATIO = CHARACTERISTIC(value) x ADVERSARY RATING
= (.40x.3)+(.35x1.0)+(.25x1.0)
= **.72**

SUMMARY AND EXPLANATION: U.S.A. rifles were judged to have equal the stopping power of Korean rifles. The 10 extra rounds in the U.S.A. rifle was judged to give it a three-fold advantage in that area. Effective range of the Korean rifle is equal to that of the U.S.A. rifle in this area.
Stopping power and feed are the overriding factors in determining lethality of rifles.

U.S. was rated at 1.0 for all factors and provides the standard against which other countries were measured.

TABLE 10. MACHINE-GUN LETHALITY FACTOR COMPONENTS; KOREAN WAR

CHARACTERISTIC (value)	U.S. specifications	Korea specifications	ADVERSARY RATING (U.S. =1.0)
CYCLIC RATE (.40)	500 rpm	600 rpm	1.2
STOPPING POWER (.40)	30 CALIBER	30 CALIBER	1.0
MUZZLE VELOCITY (.20)	853 m/s	710 m/s	.83

LETHALITY RATIO = CHARACTERISTIC(value) x ADVERSARY RATING
= (.40x1.2)+(.40x1.0)+(.2x.83)
= **1.00**

SUMMARY AND EXPLANATION: U.S.A. machine-guns were judged to have equal the stopping power of Korean machine guns. The cyclic rate of fire in the Korean machine-guns was judged to have a 20% advantage over the U.S.A. machine-gun in that area. Increase in muzzle velocity of the U.S.A. machine-gun gives it a 15% advantage in this area.

Stopping power and cyclic rate of fire are the overriding factors in determining lethality of machine-guns.

U.S. was rated at 1.0 for all factors and provides the standard against which other countries were measured.

TABLE 11. MORTAR LETHALITY FACTOR COMPONENTS; KOREAN WAR

CHARACTERISTIC (value)	U.S. specifications	Korea specifications	ADVERSARY RATING (U.S. =1.0)
RANGE (.40)	5420m	6300m	1.16
WEIGHT (.40)	275kg	180kg	1.5
CALIBER (.20)	107mm	107mm	1.0

LETHALITY RATIO = CHARACTERISTIC(value) x ADVERSARY RATING
= (.40x1.16)+(.40x1.5)+(.2x1.0)
= **1.26**

SUMMARY AND EXPLANATION: U.S.A. mortars were judged to have equal the caliber of Korean mortars. The weight of the United States mortars was judged to be greater than the Korean mortars and was judged to give it a 50% disadvantage in that area. Increase in range of the Korean mortars gives it a 15% advantage in this area.

Range and weight are the overriding factors in determining lethality of mortars.

U.S. was rated at 1.0 for all factors and provides the standard against which other countries were measured.

TABLE 12. ARTILLERY LETHALITY FACTOR COMPONENTS; KOREAN WAR

CHARACTERISTIC (value)	U.S. specifications	Korea specifications	ADVERSARY RATING (U.S. =1.0)
RANGE (.40)	14,800m	17,200m	1.16
RATE OF FIRE (.40)	3rds/min	4rds/min	1.33
CALIBER (.20)	155mm	152mm	.90

LETHALITY RATIO = CHARACTERISTIC(value)x ADVERSARY RATING
= (.40x1.16)+(.40x1.33)+(.2x.90)
= **1.18**

SUMMARY AND EXPLANATION: U.S.A. artillery were judged to have a slightly larger overall caliber than Korean artillery. The rate of fire of the Korean artillery was judged to have slightly over a one fold advantage over the U.S.A. artillery in that area. Increase in range of the Korean artillery compared to U.S.A. artillery gives it a 15% advantage in this area.

Range and rate of fire are the overriding factors in determining lethality of artillery.

U.S. was rated at 1.0 for all factors and provides the standard against which other countries were measured.

TABLE 13. MAIN BATTLE TANK LETHALITY FACTOR COMPONENTS; KOREAN WAR

CHARACTERISTIC (value)	U.S. specifications	Korea specifications	ADVERSARY RATING (U.S. =1.0)
ARMOR THICKNESS (.60)	115mm	60mm	.5
SPEED (.25)	37mph	32mph	.9
MAIN ARMAMENT (.15)	90mm	85mm	.94

LETHALITY RATIO = CHARACTERISTIC(value)x ADVERSARY RATING
= (.60x.5)+(.25x.9)+(.15x.94)
=**.67**

SUMMARY AND EXPLANATION: The armor thickness of U.S.A. main battle tanks were judged to have a 50% advantage over the Korean main battle tanks in that area. The speed of the U.S.A. main battle tanks was judged to have a 10% advantage over the Korean main battle tanks in that area. Main armament of the U.S.A. main battle tanks was judged to have a 5% advantage over the Korean main battle tanks.

Armor thickness is the overriding factor in determining lethality of main battle tanks.

U.S. was rated at 1.0 for all factors and provides the standard against which other countries were measured.

TABLE 14. PISTOL LETHALITY FACTOR COMPONENTS; VIETNAM WAR

CHARACTERISTIC (value)	U.S. specifications	Vietnam specifications	ADVERSARY RATING (U.S. =1.0)
STOPPING POWER (.75)	45 CALIBER	30 CALIBER	.67
FEED(ROUNDS) (.20)	7	8	1.14
MUZZLE VELOCITY (.05)	245 m/s	420 m/s	1.7

LETHALITY RATIO = CHARACTERISTIC(value) x ADVERSARY RATING
= (.75x.67)+(.20x1.14)+(.05x1.7)
= **.82**

SUMMARY AND EXPLANATION: U.S.A. pistols were judged to have 1.5 times the stopping power of Vietnamese pistols. The extra round in the Vietnamese pistol was judged to give it a 15% advantage in that area. Increase in muzzle velocity of the Vietnamese pistols gives it a 70% advantage in this area.

Stopping power is the overriding factor in determining lethality of pistols.

U.S. was rated at 1.0 for all factors and provides the standard against which other countries were measured.

TABLE 15. RIFLE LETHALITY FACTOR COMPONENTS; VIETNAM WAR

CHARACTERISTIC (value)	U.S. specifications	Vietnam specifications	ADVERSARY RATING (U.S. =1.0)
FEED(ROUNDS) (.40)	20	10	.5
STOPPING POWER (.35)	30 CALIBER	30 CALIBER	1.0
EFFECTIVE RANGE (.25)	300 METERS	300 METERS	1.0

LETHALITY RATIO = CHARACTERISTIC(value) x ADVERSARY RATING
= (.40x.5)+(.35x1.0)+(.25x1.0)
= **.80**

SUMMARY AND EXPLANATION: U.S.A. rifles were judged to have equal the stopping power of Vietnamese rifles. The 10 extra rounds in the U.S.A. rifles was judged to give it a 2-fold advantage in that area. Effective range of the Vietnamese rifle is equal to that of the U.S.A. rifle in this area.
Stopping power and feed are the overriding factors in determining lethality of rifles.

U.S. was rated at 1.0 for all factors and provides the standard against which other countries were measured.

TABLE 16. MACHINE-GUN LETHALITY FACTOR COMPONENTS; VIETNAM WAR

CHARACTERISTIC (value)	U.S. specifications	Vietnam specifications	ADVERSARY RATING (U.S. =1.0)
CYCLIC RATE (.40)	500rpm	600rpm	1.2
STOPPING POWER (.40)	30 CALIBER	30 CALIBER	1.0
MUZZLE VELOCITY (.20)	853 m/s	710 m/s	.8

LETHALITY RATIO = CHARACTERISTIC(value) x ADVERSARY RATING
= (.40x1.2)+(.40x1.0)+(.20x.8)
= **1.04**

SUMMARY AND EXPLANATION: United States machine-guns were judged to have equal the stopping power of Vietnamese machine-guns. The cyclic rate of fire in the Vietnamese machine-guns was judged to have a 20% advantage over the United States machine-gun in that area. Increase in muzzle velocity of the U.S.A. machine-gun gives it a 20% advantage in this area.

Stopping power and cyclic rate of fire are the overriding factors in determining lethality of machine-guns.

U.S. was rated at 1.0 for all factors and provides the standard against which other countries were measured.

TABLE 17. MORTAR LETHALITY FACTOR COMPONENTS; VIETNAM WAR

CHARACTERISTIC (value)	U.S. specifications	Vietnam specifications	ADVERSARY RATING (U.S. =1.0)
RANGE (.40)	4022m	6300m	1.14
WEIGHT (.40)	151kg	170kg	.9
CALIBER (.20)	107mm	107mm	1.0

LETHALITY RATIO = CHARACTERISTIC(value) x ADVERSARY RATING
= (.40x1.6)+(.40x.9)+(.2x1.0)
= **1.12**

SUMMARY AND EXPLANATION: U.S.A. mortars were judged to have equal the caliber of Vietnamese mortars. The weight of the United States mortars was judged to be less than the Vietnamese mortars and was judged to give it a 10% advantage in that area. Increase in range of the Vietnamese mortars gives it a 40% advantage in this area.

Range and weight are the overriding factors in determining lethality of mortars.

U.S. was rated at 1.0 for all factors and provides the standard against which other countries were measured.

TABLE 18. ARTILLERY LETHALITY FACTOR COMPONENTS; VIETNAM WAR

CHARACTERISTIC (value)	U.S. specifications	Vietnam specifications	ADVERSARY RATING (U.S. =1.0)
AIRBORNE(UH-1B) DELIVERY UTILIZATION (.35)	1.0	0.0	0
RATE OF FIRE (.25)	2rds/min	4rds/min	2.0
RANGE (.25)	23,500m	17,300m	.7
CALIBER (.15)	155mm	152mm	.98

LETHALITY RATIO = CHARACTERISTIC(value)x ADVERSARY RATING
= (.35x 0.0)+(.25x2.0)+(.25x.7)+(.15x.98)
= **.82**

SUMMARY AND EXPLANATION: The United States ability to launch artillery from a UH-1B helicopter gave us a 100% advantage in that area due to Vietnam's inability to do likewise. The United States artillery were judged to have a slightly larger overall caliber than Vietnamese artillery. The rate of fire of the Vietnamese artillery was judged to have a 2-fold advantage over the U.S. artillery in that area. Increase in range of the U.S.A. artillery compared to Vietnamese artillery gives it a 30% advantage in this area.

Airborne delivery utilization, range and rate of fire are the overriding factors in determining lethality of artillery.

U.S. was rated at 1.0 for all factors and provides the standard against which other countries were measured.

TABLE 19. BATTLEFIELD EXPLOSIVES LETHALITY FACTOR COMPONENTS; VIETNAM WAR

WEAPONRY (Battlefield Usage)	U.S. Relative Utilization (U.S.=1.0)	VIETNAM Relative Utilization (ratio to U.S.)	ADVERSARY RATING
BOOBY TRAP DEVICES (.40)	1.0	6.0	6.0
GRENADE (.30)	1.0	3.0	.30
MINES (.30)	1.0	.45	.45

LETHALITY RATIO = WEAPONRY(Battlefield Usage) x ADVERSARY RATING
= (.40x6.0)+(.30x.30)+(.30x.45)
= **2.62**

SUMMARY AND EXPLANATION: Due to battlefield conditions, booby trap devices were judged to be the most effective of the battlefield explosives, receiving the highest battlefield usage score. United States mines and grenades were judged to be approximately 50% and 70% more lethal than the Vietnamese due to our increase in the utilization of these weapons. The Vietnamese booby trap device utilization was judged to give them a six-fold advantage over the United States in that area. **Booby trap devices were the overriding factor in determining lethality of battlefield explosives.**

U.S. was rated at 1.0 for all factors and provides the standard against which other countries were measured.

TABLE 20. MAIN BATTLE TANK LETHALITY FACTOR COMPONENTS; VIETNAM WAR

CHARACTERISTIC (value)	U.S. specifications	Vietnam specifications	ADVERSARY RATING (U.S. =1.0)
ARMOR THICKNESS (.60)	75mm	60mm	.8
SPEED (.25)	30mph	32mph	1.0
MAIN ARMAMENT (.15)	105mm	85mm	.9

LETHALITY RATIO = CHARACTERISTIC(value)x ADVERSARY RATING
= (.60x.80)+(.25x1.0)+(.15x.9)
= **.87**

SUMMARY AND EXPLANATION: The armor thickness of U.S.A. main battle tanks were judged to have a 20% advantage over the Vietnamese main battle tanks in that area. The speed of the U.S.A. main battle tanks was judged to be equal to that of the Vietnamese main battle tanks in that area. Main armament of the U.S.A. main battle tanks was judged to have a 10% advantage over the Vietnamese main battle tanks.

Armor thickness is the overriding factor in determining lethality of main battle tanks.

U.S. was rated at 1.0 for all factors and provides the standard against which other countries were measured.

TABLE 21. SMALL ARMS LETHALITY FACTOR COMPONENTS; FALKLAND WAR

CHARACTERISTIC (value)	U.K. U.K.=1.0	Argentine	ADVERSARY RATING (U.K. =1.0)
MACHINE-GUN (.50)	1.0	1.0	1.0
RIFLE (.45)	1.0	1.0	1.0
PISTOL (.05)	1.0	1.0	1.0

LETHALITY RATIO = CHARACTERISTIC(value)x ADVERSARY RATING
= (.50x1.0)+(.45x1.0)+(.05x1.0)
= **1.0**

SUMMARY AND EXPLANATION: U.K. small arms were judged to be equal to Argentine small arms. **Machine-gun and rifle are the overriding factors in determining lethality of small arms.**

U.K. is rated at 1.0 for all factors and provides the standard against which its adversary was measured.

TABLE 22. MORTAR LETHALITY FACTOR COMPONENTS; FALKLAND WAR

CHARACTERISTIC (value)	U.K. U.K.=1.0	Argentine	ADVERSARY RATING (U.K. =1.0)
RANGE (.40)	6179m	4000m	.65
WEIGHT (.40)	38kg	40.5kg	.9
CALIBER (.20)	81mm	81mm	1.0

LETHALITY RATIO = CHARACTERISTIC(value) x ADVERSARY RATING
= (.40x.65)+(.40x.9)+(.2x1.0)
= **.82**

SUMMARY AND EXPLANATION: U.K. mortars were judged to have equal the caliber of Argentine mortars. The weight of the U.K. mortars was judged to be less than Argentina's mortar and was judged to give the U.K. a 10% advantage in that area. Increase in range of the U.K. mortars gives it a 35% advantage in this area.

Range and weight are the overriding factors in determining lethality of mortars.

U.K. is rated at 1.0 for all factors and provides the standard against which its adversary was measured.

TABLE 23. ARTILLERY LETHALITY FACTOR COMPONENTS; FALKLAND WAR

CHARACTERISTIC (value)	U.K. U.K.=1.0	Argentine	ADVERSARY RATING (U.K. =1.0)
RANGE (.40)	17,200m	15,300m	.9
RATE OF FIRE (.40)	8rds/min	8rds/min	1.0
CALIBER (.20)	105mm	105mm	1.0

LETHALITY RATIO = CHARACTERISTIC(value)x ADVERSARY RATING
= (.40x.9)+(.40x1.0)+(.2x1.0)
= **.96**

SUMMARY AND EXPLANATION: U.K. artillery were judged to have equal the caliber of the Argentine artillery. The range of the U.K. artillery was judged to have a 10% advantage over the Argentine artillery in that area. The rate of fire of the U.K. artillery is equal to that of the Argentine artillery.

Range and rate of fire are the overriding factors in determining lethality of artillery.

U.K. is rated at 1.0 for all factors and provides the standard against which its adversary was measured.

TABLE 24. COMPUTATION OF WEAPONS PARITY SCORE FOR U.S. ADVERSARY IN THE OKINAWA GROUND OPERATION

Weapon	Adversary Rating (battle of Okinawa)	Casualty Sustainment Index (CSI) (impact of specific weaponry on casualties sustained)	Weight (Adversary Rating x CSI)
Pistol	0.800	0.005	0.004
Rifle	0.720	0.065	0.047
Machine-gun	0.970	0.120	0.116
Mortar	0.880	0.180	0.158
Artillery	0.790	0.390	0.308
Main battle tank	0.640	0.175	0.112
Air Launched Weaponry	1.000	0.065	0.065
Weapons Parity Score (Sum of Weights)			**0.810**

TABLE 25. COMPUTATION OF WEAPONS PARITY SCORE FOR U.S. ADVERSARY IN THE KOREAN GROUND OPERATION

Weapon	Adversary Rating (Korean War)	Casualty Sustainment Index (CSI) (impact of specific weaponry on casualties sustained)	Weight (Adversary Rating x CSI)
Pistol	0.820	0.005	0.004
Rifle	0.720	0.055	0.040
Machine-gun	1.000	0.091	0.091
Mortar	1.260	0.229	0.289
Artillery	1.180	0.360	0.425
Main battle tank	0.670	0.180	0.121
Air Launched Weaponry	1.000	0.080	0.080
Weapons Parity Score (Sum of Weights)			**1.049**

TABLE 26. COMPUTATION OF WEAPONS PARITY SCORE FOR U.S. ADVERSARY IN THE VIETNAM GROUND OPERATION

Weapon	Adversary Rating (Vietnam War)	Casualty Sustainment Index (CSI) (Impact of specific weaponry on casualties sustained)	Weight (Adversary Rating x CSI)
Pistol	0.820	0.015	0.012
Rifle	0.800	0.105	0.084
Machine-gun	1.040	0.110	0.114
Mortar	1.120	0.205	0.246
Artillery	0.820	0.245	0.258
Main battle tank	0.870	0.095	0.100
Battlefield explosives	2.620	0.120	0.314
Air Launched Weaponry	0.001	0.105	0.000
Weapons Parity Score (Sum of Weights)			**1.128**

TABLE 27. COMPUTATION OF WEAPONS PARITY SCORE FOR U.K. ADVERSARY IN THE FALKLANDS GROUND OPERATION

Weapon	Adversary Rating (Falklands War)	Casualty Sustainment Index (CSI) (impact of specific weaponry on casualties sustained)	Weight (Adversary Rating x CSI)
Pistol	1.000	0.005	0.005
Rifle	1.000	0.090	0.090
Machine-gun	1.000	0.195	0.195
Mortar	0.820	0.230	0.189
Artillery	0.960	0.330	0.317
Air Launched Weaponry	0.500	0.150	0.075
Weapons Parity Score (Sum of Weights)			**0.871**

TABLE 28. ARTILLERY RATING SCORES USED IN U.S. GROUND CASUALTY PROJECTIONS

NATION	State of Art Rating Towed Artillery (weight = .19)	+	State of Art Rating Self-Propelled Artillery (weight = .30)	+	State of Art Rating MLRS (weight = .26)	+	No. of Artillery Pieces Rating (weight = .25)	=	Artillery Score
1	0.690	+	0.850	+	0.750	+	0.107	=	**0.608**
2	0.680	+	0.800	+	0.700	+	N/A	=	**0.551**
3	0.700	+	0.850	+	0.750	+	0.119	=	**0.613**
4	0.750	+	0.830	+	0.750	+	0.043	=	**0.597**
5	0.710	+	0.830	+	0.740	+	0.187	=	**0.623**
6	0.740	+	0.750	+	0.740	+	1.000	=	**0.808**
7	0.730	+	0.830	+	0.000	+	0.130	=	**0.420**
8	0.760	+	0.830	+	0.700	+	0.009	=	**0.578**
9	0.750	+	0.800	+	0.800	+	0.149	=	**0.628**
10	0.800	+	0.890	+	0.740	+	0.231	=	**0.669**
11	0.760	+	0.850	+	0.780	+	0.175	=	**0.646**
12	0.700	+	0.000	+	0.740	+	N/A	=	**0.325**
13	0.810	+	0.870	+	0.750	+	0.100	=	**0.635**
14	0.710	+	0.830	+	0.740	+	0.550	=	**0.714**
15	0.780	+	0.880	+	0.750	+	0.161	=	**0.648**
16	0.690	+	0.800	+	0.780	+	0.250	=	**0.636**
17	0.770	+	0.830	+	0.750	+	1.000	=	**0.840**
18	0.760	+	0.850	+	0.830	+	0.046	=	**0.627**
19	0.760	+	0.930	+	0.750	+	0.014	=	**0.622**
20	0.700	+	0.830	+	0.740	+	0.305	=	**0.651**
21	0.700	+	0.920	+	0.000	+	0.013	=	**0.412**
22	0.880	+	0.940	+	0.850	+	0.763	=	**0.861**
23	0.720	+	0.800	+	0.730	+	0.150	=	**0.604**
24	0.750	+	0.850	+	0.700	+	N/A	=	**0.580**

Artillery Score = (Towed SOA rating x weight) + (Self Propelled SOA rating x weight) + (MLRS SOA rating x weight) + (Artillery rating x weight)

TABLE 29. ARMOR RATING SCORES USED IN U.S. GROUND CASUALTY PROJECTIONS

NATION	State of Art Rating Main Battle Tank (weight = .45)	+	State of Art Rating APC/Fighting Vehicles (weight = .20)	+	State of Art Rating Recon. Vehicles (weight = .05)	+	No. of Armor Pieces Rating (weight = .30)	=	Armor Score
1	0.670	+	0.750	+	0.700	+	0.013	=	**0.490**
2	0.660	+	0.770	+	0.700	+	0.002	=	**0.487**
3	0.710	+	0.770	+	0.700	+	0.024	=	**0.516**
4	0.670	+	0.760	+	0.700	+	0.004	=	**0.490**
5	0.690	+	0.790	+	0.720	+	0.035	=	**0.515**
6	0.720	+	0.740	+	0.000	+	0.150	=	**0.517**
7	0.710	+	0.750	+	0.700	+	0.027	=	**0.513**
8	0.730	+	0.810	+	0.820	+	0.004	=	**0.533**
9	0.700	+	0.780	+	0.700	+	0.038	=	**0.518**
10	0.730	+	0.750	+	0.830	+	0.016	=	**0.525**
11	0.700	+	0.800	+	0.770	+	0.033	=	**0.523**
12	0.670	+	0.750	+	0.000	+	0.002	=	**0.452**
13	0.690	+	0.820	+	0.800	+	0.038	=	**0.526**
14	0.690	+	0.750	+	0.700	+	0.068	=	**0.516**
15	0.700	+	0.790	+	0.800	+	0.030	=	**0.522**
16	0.660	+	0.780	+	0.750	+	0.057	=	**0.508**
17	0.710	+	0.780	+	0.700	+	1.000	=	**0.811**
18	0.700	+	0.790	+	0.790	+	0.038	=	**0.524**
19	0.710	+	0.790	+	0.740	+	0.005	=	**0.516**
20	0.710	+	0.770	+	0.750	+	0.091	=	**0.538**
21	0.780	+	0.830	+	0.780	+	0.003	=	**0.557**
22	0.800	+	0.900	+	1.000	+	0.788	=	**0.826**
23	0.680	+	0.770	+	0.700	+	0.030	=	**0.504**
24	0.690	+	0.790	+	0.770	+	N/A	=	**0.507**

Armor Score = (MBT SOA rating x weight) + (Recon. SOA rating x weight) + (APC/FV SOA rating x weight) + (Armor rating x weight)

TABLE 30. INFANTRY RATING SCORES USED IN U.S. GROUND CASUALTY PROJECTIONS

NATION	State of Art Rating Machine-Gun (weight = .30)	+	State of Art Rating Mortar (weight = .30)	+	State of Art Rating Anti-Tank (weight = .20)	+	State of Art Rating Close-Support (weight = .10)	+	State of Art Rating Submachine-Gun (weight = .05)	+	State of Art Rating Rifle (weight = .05)	=	Infantry Score
1	0.730	+	0.750	+	0.820	+	0.900	+	0.800	+	0.780	=	**0.777**
2	0.740	+	0.750	+	0.830	+	0.000	+	0.850	+	0.800	=	**0.696**
3	0.720	+	0.750	+	0.820	+	0.000	+	0.900	+	0.840	=	**0.692**
4	0.710	+	0.750	+	0.800	+	0.000	+	0.830	+	0.840	=	**0.682**
5	0.740	+	0.750	+	0.830	+	0.000	+	0.800	+	0.780	=	**0.692**
6	0.620	+	0.710	+	0.750	+	0.880	+	0.740	+	0.780	=	**0.713**
7	0.760	+	0.750	+	0.840	+	0.000	+	0.800	+	0.830	=	**0.703**
8	0.730	+	0.780	+	0.880	+	0.000	+	0.900	+	0.870	=	**0.718**
9	0.880	+	0.750	+	0.840	+	0.000	+	0.950	+	0.900	=	**0.750**
10	0.820	+	0.830	+	0.870	+	0.000	+	0.930	+	0.880	=	**0.760**
11	0.710	+	0.750	+	0.870	+	0.000	+	0.900	+	0.780	=	**0.696**
12	0.740	+	0.780	+	0.800	+	0.000	+	0.700	+	0.880	=	**0.695**
13	0.760	+	0.790	+	0.850	+	0.000	+	0.900	+	0.850	=	**0.723**
14	0.730	+	0.750	+	0.810	+	0.000	+	0.700	+	0.800	=	**0.681**
15	0.730	+	0.800	+	0.860	+	0.000	+	0.950	+	0.850	=	**0.721**
16	0.670	+	0.770	+	0.840	+	0.000	+	0.700	+	0.850	=	**0.678**
17	0.790	+	0.780	+	0.790	+	0.850	+	0.750	+	0.890	=	**0.796**
18	0.860	+	0.850	+	0.870	+	0.930	+	0.930	+	0.920	=	**0.873**
19	0.730	+	0.800	+	0.850	+	0.000	+	0.930	+	0.820	=	**0.717**
20	0.650	+	0.750	+	0.840	+	0.000	+	0.700	+	0.920	=	**0.669**
21	0.850	+	0.790	+	0.890	+	0.000	+	0.900	+	0.880	=	**0.759**
22	0.920	+	0.890	+	0.890	+	0.890	+	0.930	+	0.900	=	**0.902**
23	0.640	+	0.780	+	0.810	+	0.000	+	0.850	+	0.780	=	**0.670**
24	0.880	+	0.790	+	0.860	+	0.800	+	0.830	+	0.800	=	**0.835**

Infantry Weapon's Score = (M.G. SOA rating x weight) + (Mort. SOA rating x weight) + (A.T. SOA rating x weight) + (Rifle SOA rating x weight) + (SMG SOA rating x weight) + (Close supp. SOA rating x weight)

TABLE 31. AIRBORNE ATTACK AND DETECTION RATING SCORES USED IN U.S. GROUND CASUALTY PROJECTIONS

NATION		State of Art Rating Radar (weight = .11)	+	State of Art Rating Electronic Warfare (weight = .03)	+	State of Art Rating Helicopter (weight = .16)	+	No. of Helicopters Rating (weight = .12)	+	State of Art Rating Missile (weight = .20)	+	State of Art Rating Aircraft (weight = .25)	+	No. of Aircraft Rating (weight = .13)	=	Flight and Detection Score
1	A	0.000	+	0.000	+	0.500	+	0.009	+	0.100	+	0.400	+	0.018	=	**0.203**
2	B	0.000	+	0.000	+	0.300	+	0.002	+	0.100	+	0.400	+	0.011	=	**0.170**
3	C	0.000	+	0.000	+	0.500	+	0.008	+	0.300	+	0.500	+	0.016	=	**0.268**
4	D	0.000	+	0.000	+	0.500	+	0.009	+	0.100	+	0.500	+	0.006	=	**0.227**
5	G	0.200	+	0.100	+	0.700	+	0.011	+	0.200	+	0.700	+	0.024	=	**0.356**
6	I	0.300	+	0.200	+	0.700	+	0.041	+	0.400	+	0.700	+	0.497	=	**0.475**
7	J	0.000	+	0.000	+	0.700	+	0.012	+	0.400	+	0.700	+	0.024	=	**0.371**
8	K	0.000	+	0.000	+	0.100	+	0.000	+	0.100	+	0.100	+	0.001	=	**0.061**
9	O	0.200	+	0.000	+	0.700	+	0.059	+	0.400	+	0.800	+	0.078	=	**0.431**
10	P	0.000	+	0.000	+	0.600	+	0.014	+	0.300	+	0.700	+	0.044	=	**0.338**
11	Q	0.000	+	0.000	+	0.300	+	0.055	+	0.100	+	0.300	+	0.028	=	**0.153**
12	S	0.000	+	0.000	+	0.200	+	0.001	+	0.100	+	0.200	+	0.003	=	**0.102**
13	T	0.000	+	0.000	+	0.400	+	0.011	+	0.300	+	0.400	+	0.039	=	**0.230**
14	U	0.000	+	0.000	+	0.700	+	0.023	+	0.400	+	0.700	+	0.048	=	**0.376**
15	V	0.000	+	0.000	+	0.700	+	0.003	+	0.400	+	0.700	+	0.043	=	**0.373**
16	X	0.000	+	0.100	+	0.500	+	0.022	+	0.300	+	0.600	+	0.042	=	**0.301**
17	Y	0.400	+	0.400	+	0.900	+	0.356	+	0.500	+	0.900	+	0.689	=	**0.657**
18	AA	0.300	+	0.200	+	0.800	+	0.004	+	0.300	+	0.600	+	0.012	=	**0.379**
19	AB	0.000	+	0.000	+	0.500	+	0.005	+	0.300	+	0.500	+	0.005	=	**0.266**
20	AC	0.000	+	0.000	+	0.600	+	0.037	+	0.300	+	0.700	+	0.047	=	**0.342**
21	AD	0.000	+	0.000	+	0.500	+	0.004	+	0.200	+	0.500	+	0.005	=	**0.246**
22	AF	0.500	+	0.500	+	1.000	+	0.980	+	0.500	+	1.000	+	0.765	=	**0.797**
23	AH	0.000	+	0.000	+	0.600	+	0.015	+	0.300	+	0.600	+	0.029	=	**0.312**
24	AJ	0.200	+	0.200	+	0.600	+	0.000	+	0.300	+	0.600	+	0.000	=	**0.334**

Flight & Detection Score = (Radar SOA rating x weight) + (E.W. rating x weight) + (Hel. SOA rating x weight) + (Hel. # rating x weight) + (Miss. rating x weight) + (Air. rating x weight) + (Air. # rating x weight)

TABLE 32. OVERALL WEAPONS RATING SCORES USED IN U.S. GROUND CASUALTY PROJECTIONS

NATION	Artillery(0.25)	+	Armor(0.20)	+	Infantry Weap.(0.10)	+	Air. & Detect.(0.45)	=	Overall Rating
1	0.608	+	0.490	+	0.777	+	0.203	=	**0.419**
2	0.551	+	0.487	+	0.696	+	0.170	=	**0.381**
3	0.613	+	0.516	+	0.692	+	0.268	=	**0.446**
4	0.597	+	0.490	+	0.682	+	0.227	=	**0.417**
5	0.623	+	0.515	+	0.692	+	0.356	=	**0.488**
6	0.808	+	0.517	+	0.713	+	0.475	=	**0.591**
7	0.420	+	0.513	+	0.703	+	0.371	=	**0.445**
8	0.578	+	0.533	+	0.718	+	0.061	=	**0.350**
9	0.628	+	0.518	+	0.750	+	0.431	=	**0.529**
10	0.669	+	0.525	+	0.760	+	0.338	=	**0.500**
11	0.646	+	0.523	+	0.696	+	0.153	=	**0.405**
12	0.325	+	0.452	+	0.695	+	0.102	=	**0.287**
13	0.635	+	0.526	+	0.723	+	0.230	=	**0.440**
14	0.714	+	0.516	+	0.681	+	0.376	=	**0.519**
15	0.648	+	0.522	+	0.721	+	0.373	=	**0.506**
16	0.636	+	0.508	+	0.678	+	0.301	=	**0.464**
17	0.840	+	0.811	+	0.796	+	0.657	=	**0.748**
18	0.627	+	0.524	+	0.873	+	0.379	=	**0.519**
19	0.622	+	0.516	+	0.717	+	0.266	=	**0.450**
20	0.651	+	0.538	+	0.669	+	0.342	=	**0.491**
21	0.412	+	0.557	+	0.759	+	0.246	=	**0.401**
22	0.861	+	0.826	+	0.902	+	0.797	=	**0.829**
23	0.604	+	0.504	+	0.670	+	0.312	=	**0.459**
24	0.580	+	0.507	+	0.835	+	0.334	=	**0.480**

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The FORECAS ground casualty projection tool was designed to forecast the numbers of wounded and killed likely to be incurred among Marines and originally based its casualty estimates on those observed in previous combat operations. Adversary-specific adjustments to the casualty projections were required, however, to reflect the degrees of parity between U.S. forces and future potential enemy forces within two domains: 1) combat motivation, and 2) weapons capabilities. A Subject Matter Expert (SME) panel was assembled to specify societal variables that might be reflective of motivational factors and to reach consensus on how these factors might most appropriately be weighed. Societal factors selected included battlefield experience, societal homogeneity, defense spending priority, and technological sophistication. Contrasts were also performed between the weapons inventories of the U.S. and potential adversaries. Armaments were quantified in terms of level of technology and the quantities within four weapons categories: infantry, armor, artillery, and attack aircraft and detection hardware. FORECAS casualty projections now incorporate the degrees of present-day weapons parity and motivational parity between opposing forces.

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